

The Black Sea Region a Future Hub for Unconventionals: The Romanian perspective

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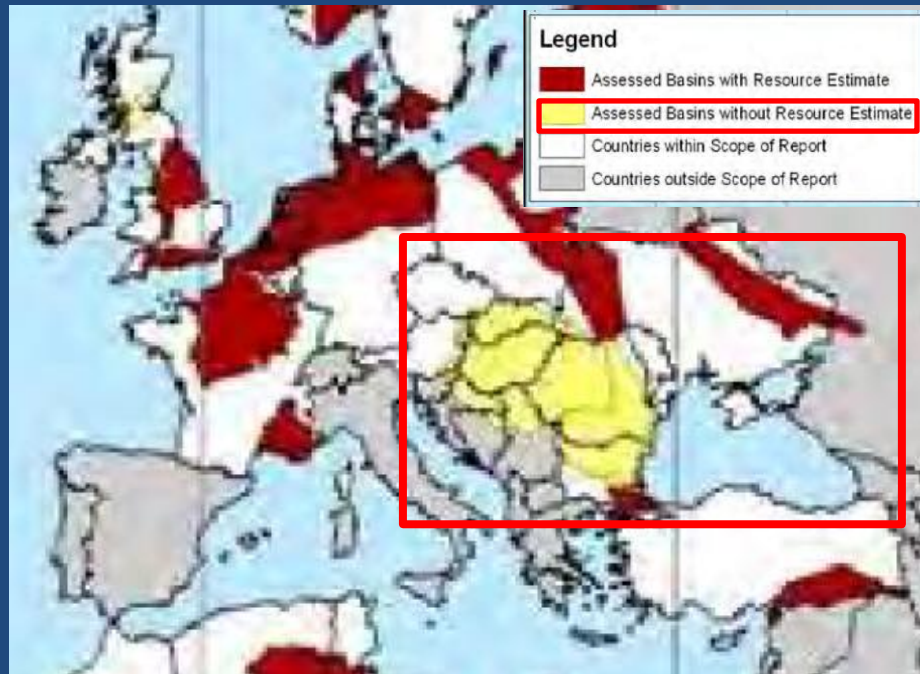
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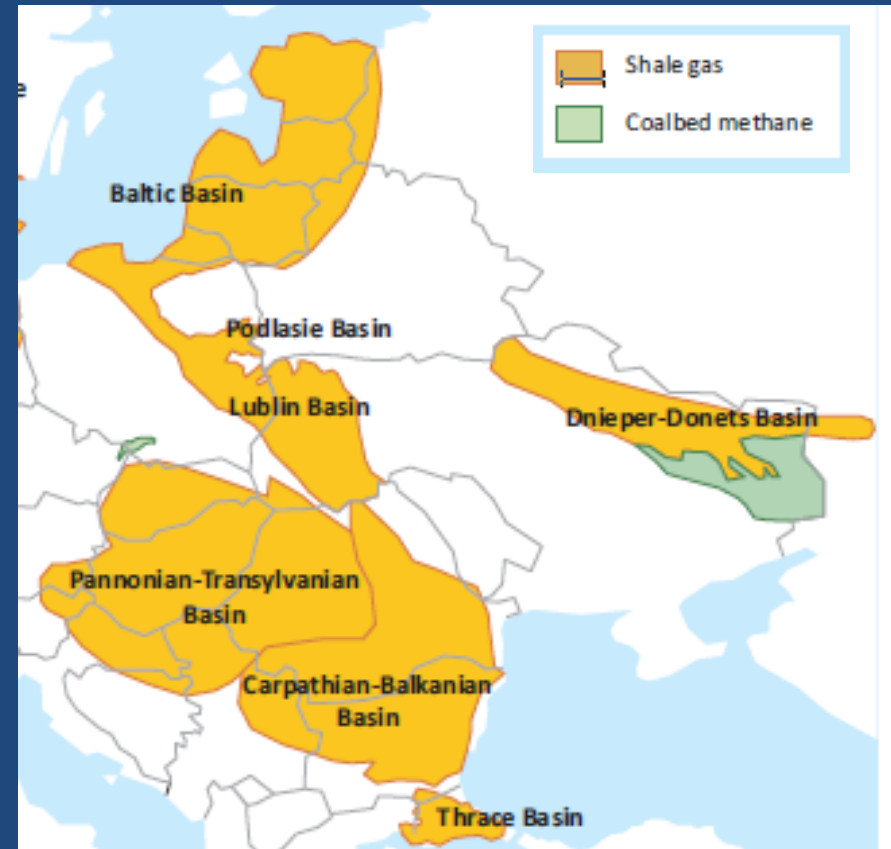
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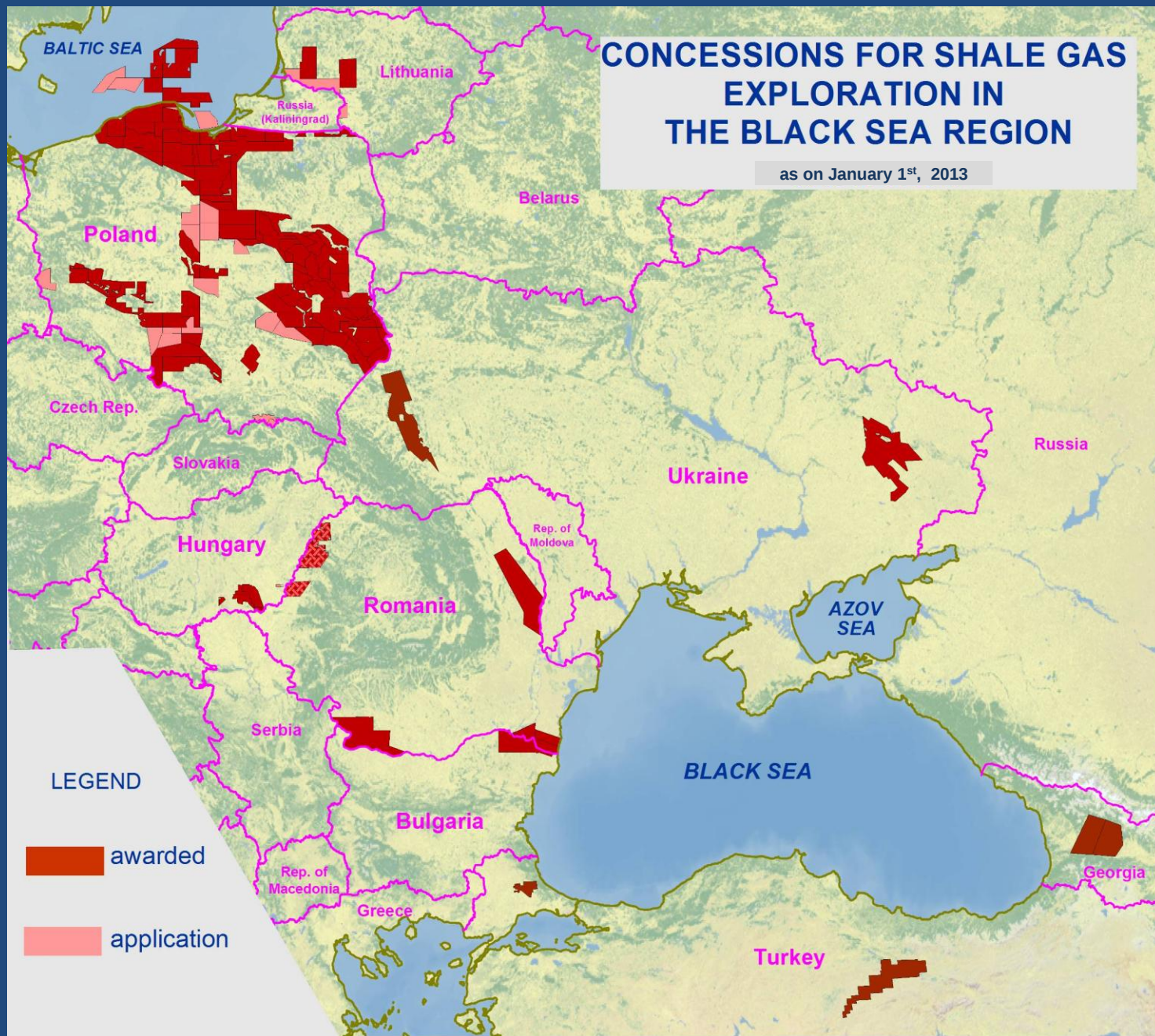
Map of major Shale Basins in Europe **2011**

from *“World Shale Gas Resources: An Initial Assessment of
14 Regions Outside the United States, 2011”*
by U. S. Energy Information Administration



Major unconventional natural gas resources in Eastern Europe **2012**

(after *“World Energy Outlook Special Report on
Unconventional Gas: Golden Rules for a Golden Age of
Gas”*, by U.S. Energy Information Administration 2012)



**ESTIMATED
RECOVERABLE
RESOURCES
[Tcm] :**

Poland
3.00-5.00 (y.2011)
0.35-0.77 (y.2012)

Lithuania
0.42

Ukraine
average 1.2

Romania
0.93

Hungary
0.4-1.0

Bulgaria
0.3-1.0

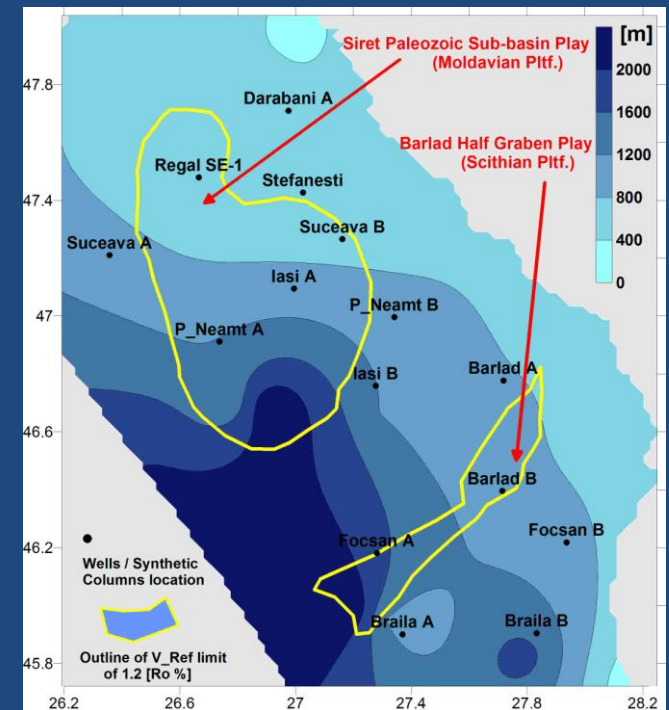
Turkey
0.4-0.8

Georgia
0.2-0.7

Study Goals and Undertakings for Romania:

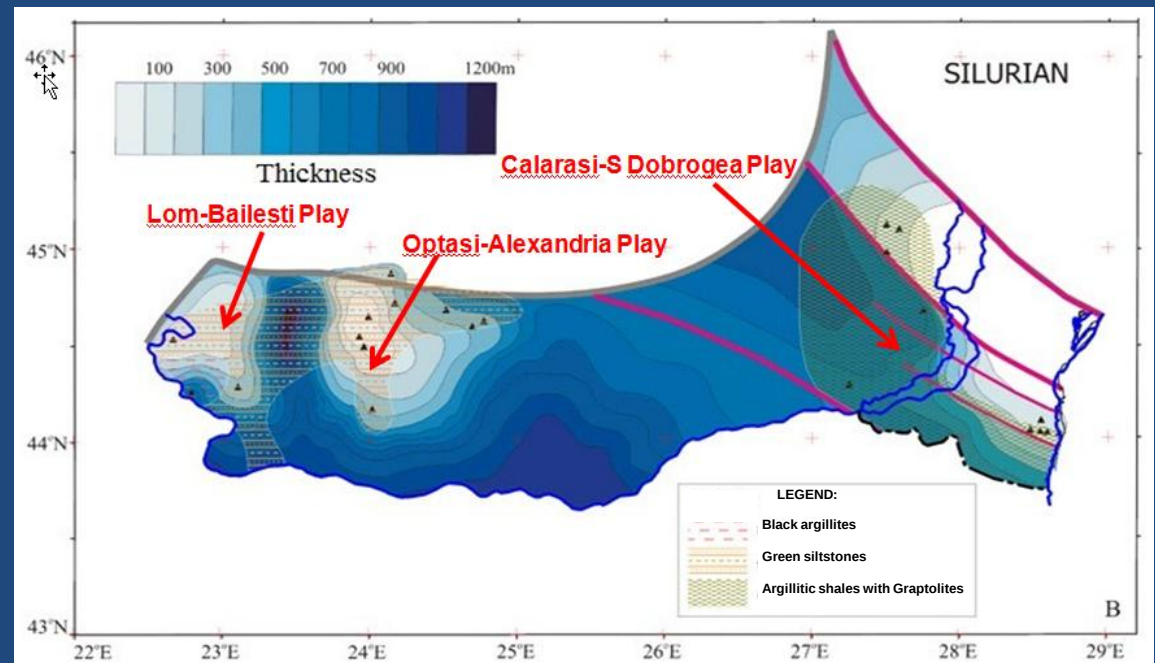
1. Initial stratigraphic and reservoir evaluation of the Paleozoic shale basins and plays.
2. Define areal extent of the major shale plays.
3. Define the prospective area for each shale plays.
4. Estimate the original gas in-place (OGIP).
5. Evaluate the technically recoverable **shale gas resources**.

Isopach Map of Silurian and Ordovician Formations from *Moldavian Platform* and *Scythian Platform*.



Isopach and Facies of the Silurian from the *Moesian Platform*

(modified from A.Seghedi, 2004)



Recommended peer-review Assessment Methods by US Geological Survey

- **Volumetric** (*the assessment uses a geology-based methodology*)
- Material balance (p/z-plots)
- Analogy
- Decline curves
- History matching
- Type curves

**Assessment method
used for this study:**



Volumetric calculation formula
applied by U. S. Energy
Information Administration for
*World Shale Gas Resources:
An Initial Assessment of 14
Regions Outside the United
States, 2011*

The calculation of **free gas in-place (GIP)** uses
the following standard reservoir engineering
equation:

$$GIP = \frac{43,560 * A h \Phi (1 - S_w)}{B_g}$$

Where: $B_g = \frac{0.02829 z T}{P}$

Adsorbed gas in-place is calculated using the
formula below (where P is original reservoir
pressure).

$$GC = (VL * P) / (PL + P)$$

Basic data	Moldavian Platform sub-basins	Siret Paleozoic Sub-basin (Moldavian Pltf.)	Barlad Barlad Half Graben (Scithian Pltf.)
	Shale formations	Shales (20-30%); Limestones (30-50%); Sanstones (30%)	Shales (20-30%); Limestones (30-50%); Sanstones (30%)
	Geologic age	Silurian-Ordovician	Devonian-Silurian-Ordovician
Physical extent	Max. Prospective Area (acres\sq.km)	2,031,983 \ 8,223	272,267 \ 1,102
	Depth at the top of formations organically rich (ft\m)	1,312-7,709 400-2,350	2,953–12,467 900-3,800
	Average net thickness of formations organically rich (ft\m)	98 30	82 25
Reservoir properties	Pressure (Mpa\psi)	35 3481	30 5366
	Temperature [Rankin]	684	691
	TOC (wt %)	1.1-1.6	1.0-2.4
	Thermal maturity (%Ro)	0.35-1.6	0.58-3.6
	Volume factor Bg	0.0048	0.0033
	z-factor	0.860	0.900

Shale Gas Reservoirs Properties of the Paleozic formations in the Moldavian Platform

Basic data	MOESIA Sub-basins	Lom-Bailesti	Optasi Uplift (Alexandria margin)	Calarasi and South Dobrogea
	Shale formations	black shales, argillites	shales, argillites	argillites, shales, argillaceous schists
	Geologic age	Silurian- Lower&Mid Devonian	Silurian- Lower&Mid Devonian	Silurian- Lower&Mid Devonian
Physical extent	Prospective Area (acres/ sq.km)	196,307/ 794.4	2,098,981/ 8,494.3	2,953,543/ 11,952.6
	Depth at the top of formations organically rich (ft/ m)	10,100-14,400 3,078-4,389	6,600 – 8,200 2,012 – 2,499	3,000 - 12,500 914 – 3,810
	Average thickness of formations organically rich (ft/ m)	1,132/345	2,457/749	1,217/371
Reservoir properties	Pressure (Mpa/ psi)	35/5,076	30/4,351	28/4,061
	Temperature [Rankin]	663	654	636
	TOC (wt %)	0.428-1.966	0.800-1.500	0.728-1.457
	Thermal maturity (%Ro)	0.74-1.90	0.85-1.40	1.00-1.50
	Volume factor Bg	0.0037	0.0043	0.0049
	z-factor	0.9922	1.0000	1.1000

***Shale Gas
Reservoirs
Properties
of the
Paleozoic
formations
from
Moesia***

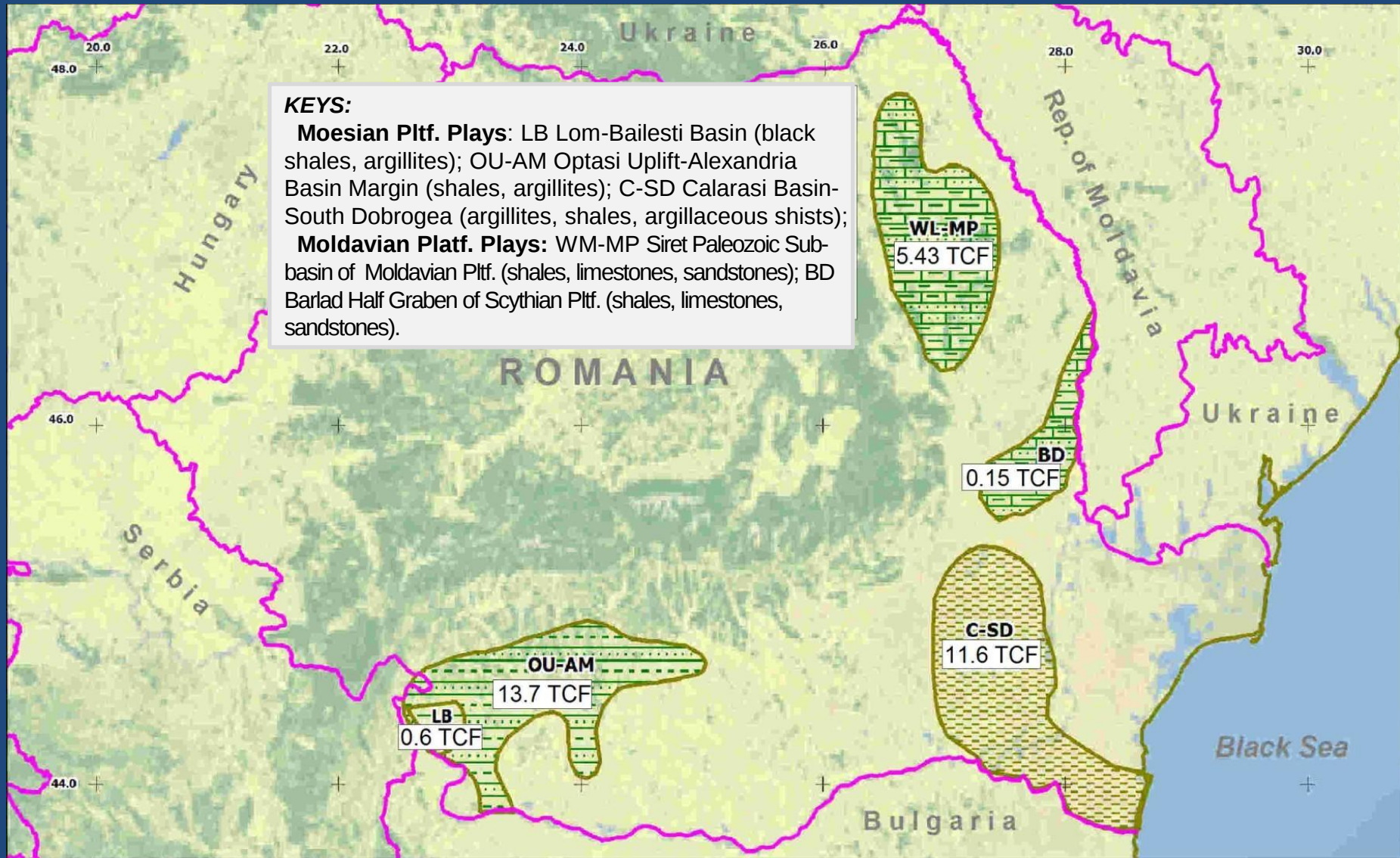
Shale Gas Resources Assessment of the Paleozoic pays of Moesia

PLAYS		Lom-Bailesti			Optasi Uplift (Alexandria margin)			Calarasi and South Dobrogea		
Assessment hypothesis		Pesimistic	Mean (Swanson's)	Optimistic	Pesimistic	Mean (Swanson's)	Otimisticp	Pesimistic	Mean (Swanson's)	Optimistic
Resources	Original gas in place OGIP (Tcf)	29			687			579		
	Technically recoverable (Tcf)	0.3	0.6 (0.58)	0.9	6.9	13.7 (13.73)	20.6	5.8	11.6 (12.44)	17.4

Shale Gas Resources Assessment of the Paleozoic Plays of the Moldavian Platform

PLAYS		Siret Paleozoic Sub-basin (Moldavian Pltf.)			Barlad Half Graben (Scithyan Pltf.)		
Assessment hypothesis		Pessimistic (P10)	Mean (P50)	Optimistic (P90)	Pessimistic (P10)	Mean (P50)	Optimistic (P90)
Resources	Original gas in place OGIP (Tcf)	271.74			7.30		
	Technically recoverable (Tcf)	2.71	5.43	8.15	0.07	0.15	0.22

Shale Gas Resources Plays & Facies of the Paleozoic Plays of Romania

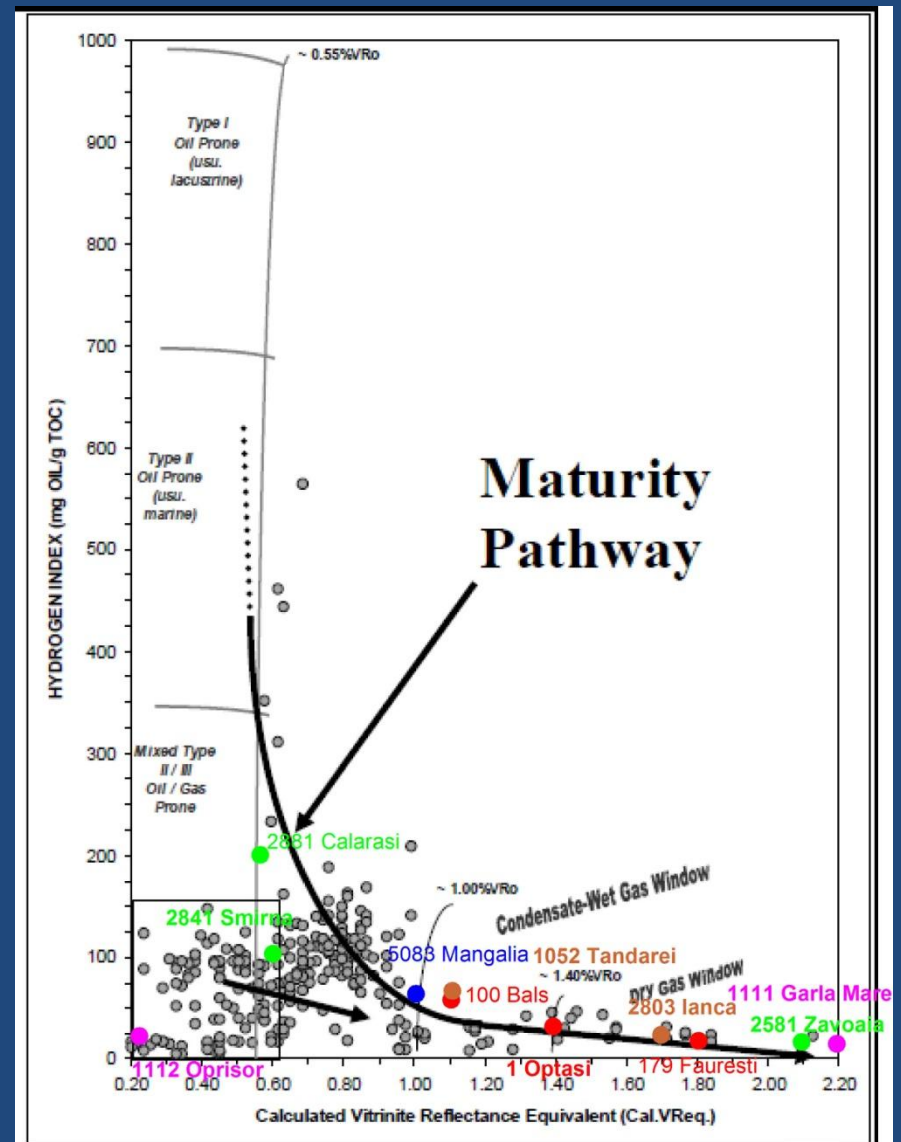
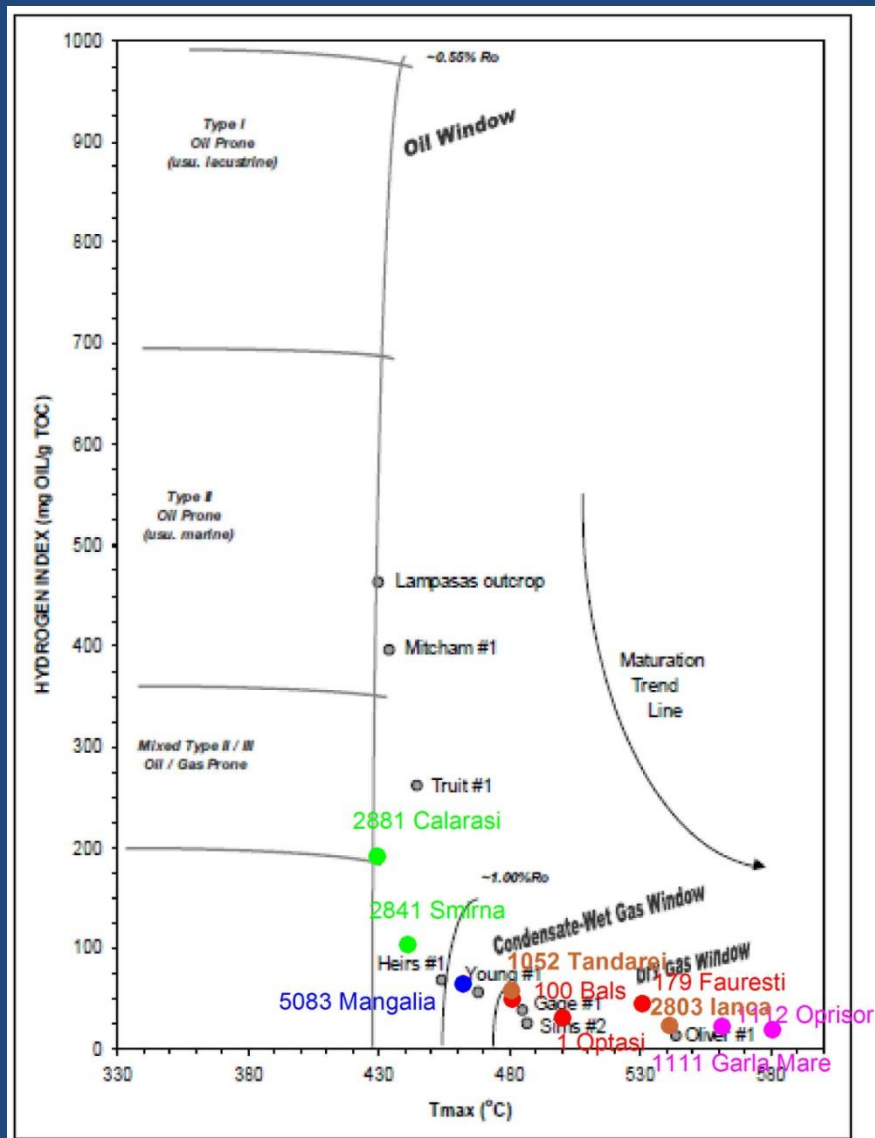


Comparison of the U.S. and Romanian (Moesian and Moldavian Platforms) plays

Left: Hydrogen Index vs. Tmax .

Right: Hydrogen Index vs. Calculated Vitrinite Reflectivity Equivalent.

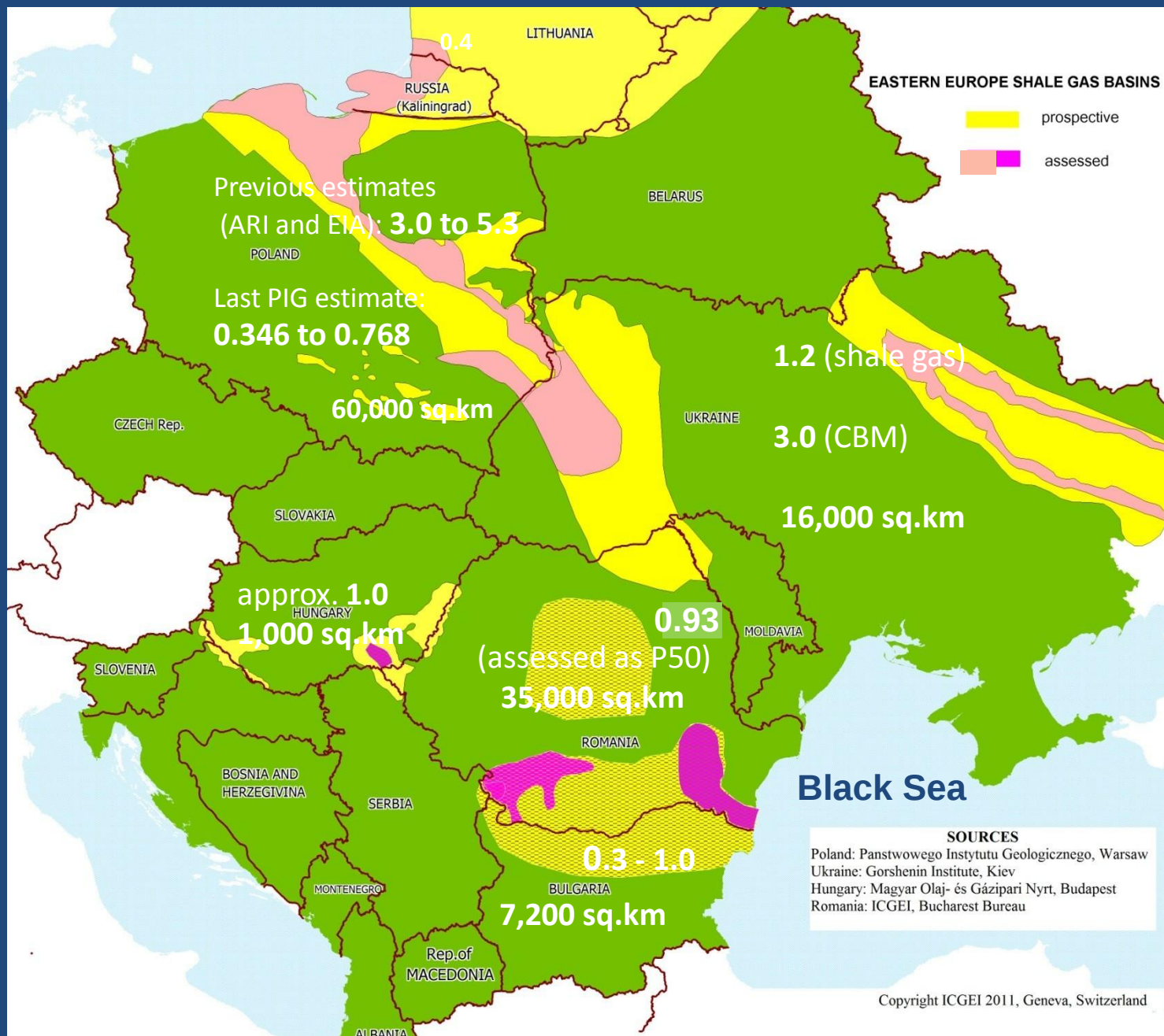
(Keys: gray points = US wells; colored points = Romanian wells)



Eastern Europe Shale Gas Estimations

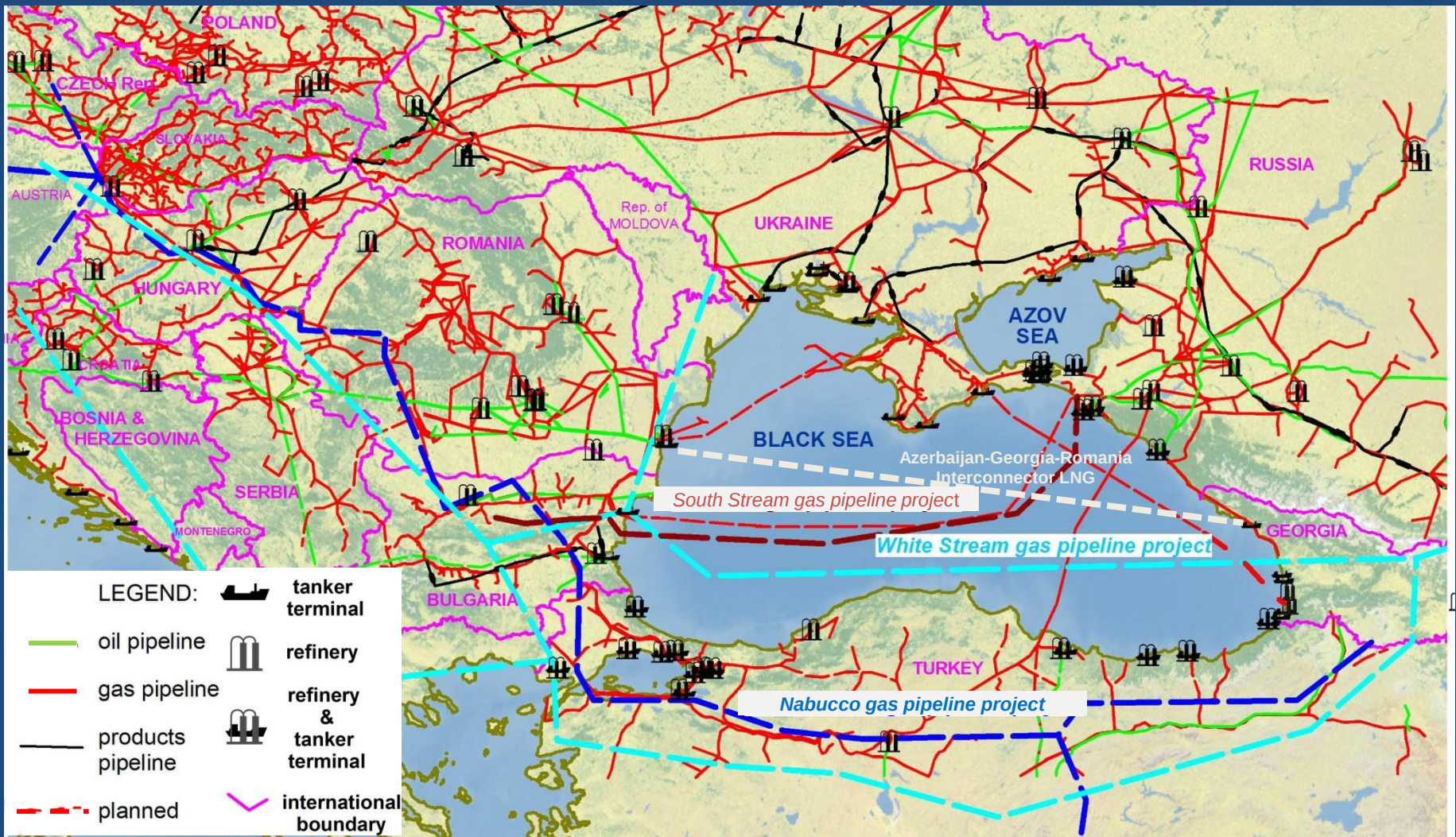
Resources:
Risky
Recoverable
in **Tcm**

Approximate
areas with
Paleozoic
formations
(except
Hungary and
Transylvanian
Basin in
Romania
that are
Neogene)



Strenghts and benefits of shale gas exploration and production in Romania:

- Large Paleozoic shale deposits. (The resulting assessment of **0.93Tcm** technically recoverable resources clearly shows that this resource potential of Romania should make a significant contribution to the country's energy mix over the next 20-30 years).
- Hydraulic fracturing has been practiced in Romania for the past 40 years. During the 1920's, Romania was the 6th largest oil producer in the world.
- The applicable legislation is already in place. (There is no specific Romanian legislation related to shale gas. According to the definition of natural gas in the Petroleum Law, production of shale gas is covered by the text of the law).
- There is sustained investment interest in the Black Sea region by international oil and gas companies. This is most encouraging.
- Authorities must adopt a flexible tax strategy aimed at supporting companies that are able to invest in Romania to exploring this new play. Also, informing the public of both the economical benefits and environmental risks of shale gas exploitation.
- Romania's role could be crucial as it is already leading efforts for increased oil and gas production in the Black Sea region and could become the first gas exporting country to Central and SE Europe.



Existing infrastructure from the Black Sea region facilitates the development of commercial use of natural gas from shale formations.



Thank you!

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